Soil temperature variations between a Typic Fragiudults and a Typic Paleudults in the Ozark Highlands of Missouri

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Background

Soil temperature measurements from a Soil Climate Analysis Network (SCAN) monitoring site in the Ozark Highlands Major Land Resource Area (MLRA 116A) were evaluated on landscapes comprising *Typic Fragiudults* (Scholten series) and *Typic Paleudults* (Poynor series). The five soil forming factors were similar for both soils, with the major difference between the adjacent soils being a fragipan in the Scholten series (Figure 1). The objective of this work was to evaluate soil temperature variations between a pedon classified as a Typic Fragiudults and an adjacent pedon classified as a Typic Paleudults in the Ozark Highlands Major Land Resource Area (MLRA 116A) (USDA-NRCS, 2006) of Missouri.

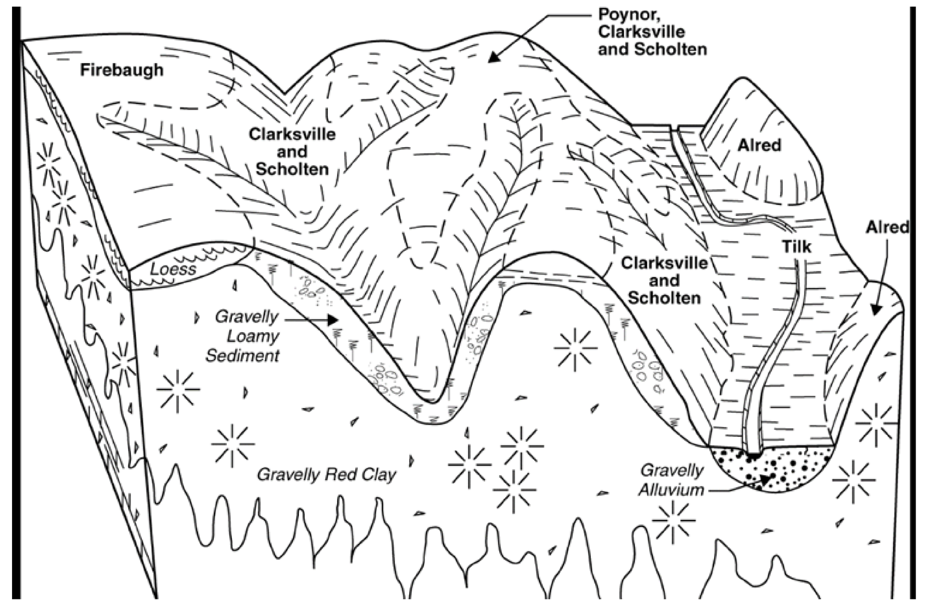

Figure 1. Typical pattern of soils and parent material of the Poynor-Scholten soil series.

Materials and Methods

Pedons were described and sampled using standard methods (Schoeneberger et al., 2012), and physical and chemical analysis were completed by the Kellogg Soil Survey Laboratory (Soil Survey Staff 2014). Descriptions and data are presented in Tables 1 and 2, and in Figures 4 and 5. Air and soil temperature were collected from a SCAN weather station of the USDA-Natural Resources Conservation Service near the border of the mesic soil temperature regime and udic soil moisture regime zone (Figure 2, Figure 3). Soil temperature measurements from a climate-monitoring network in Missouri were collected for a period of 7 years. The results were used to verify and update taxonomic classification, to provide a more precise soil temperature estimate for the Ozark Highlands, and to provide reference data for future research in soils with fragipans.

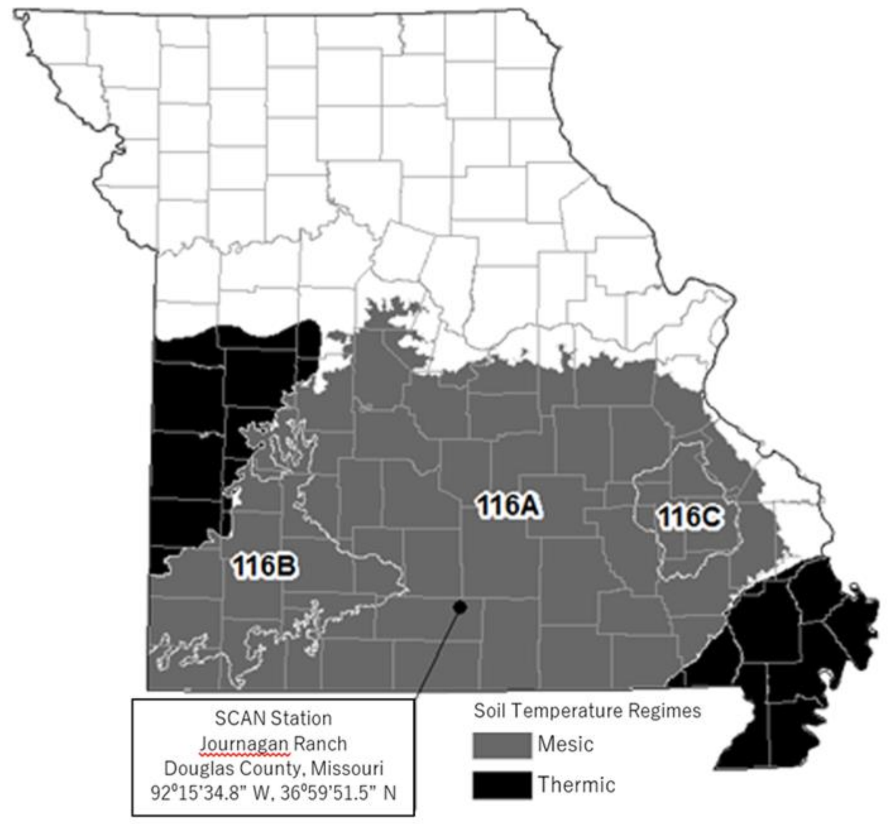

Figure 2. Location of the Journagan Ranch SCAN site, Douglas County, Missouri in relation to Major Land Resource Areas (MLRA's) and Soil Temperature Regimes.

Figure 3. Journagan Ranch SCAN site at Douglas County Missouri.

Schoeneberger, P.J., D.A. Wysocki, E.C. Benham, and Soil Survey Staff. 2012. Field book for describing and sampling soils. V. 3.0

Soil Survey Staff. 2014. Kellogg Soil Survey Laboratory Methods Manual. Soil Survey Investigations Report No. 42, V. 5.0.

Scholten Soils

The Scholten series consists of very deep, moderately well drained soils that have a fragipan and are found he upper shoulders on hillslopes (Figure 3). These soils formed in colluvium and the underlying residuum weathered from cherty limestone.

Table 1. Soil profile description summary for the Scholten pedon.

Scholten series soil profile							
Horizon	Depth (cm)	Matrix colors (moist)	Texture	Coarse fragments > 2 mm (%)	Clay content (%)	Structure	pH (H_2O, 1:1)
Ap	0 to 13	10YR 4/3	silt loam	29	11.3	weak fine subangular blocky	6.0
Bt_1	13 to 28	10YR 5/6	silt loam	29	14.2	moderate medium subangular blocky	5.9
Bt_2	28 to 38	10YR 5/6	silt loam	53	20.0	moderate fine subangular blocky	5.7
$2Btx_1$	38 to 50	7.5YR 5/4	silt loam	60	22.7	moderate very fine subangular blocky	5.1
$2Btx_2$	50 to 67	10YR 6/4 (80%) and 2.5YR 4/6 (20%)	silt loam	64	20.2	moderate very fine subangular blocky	4.8
$3Bt_1$	67 to 95	2.5YR 4/6	silt loam	17	13.1	strong fine subangular blocky	4.7
$3Bt_2$	95 to 125	10YR 7/6	clay	57	64.2	moderate fine subangular blocky	4.7
$3Bt_3$	125 to 160	10YR 7/6	clay	40	56.0	moderate medium subangular blocky	4.7
$3Bt_4$	160 to 203	10YR 7/6	clay	26	69.7	moderate medium subangular blocky	4.6

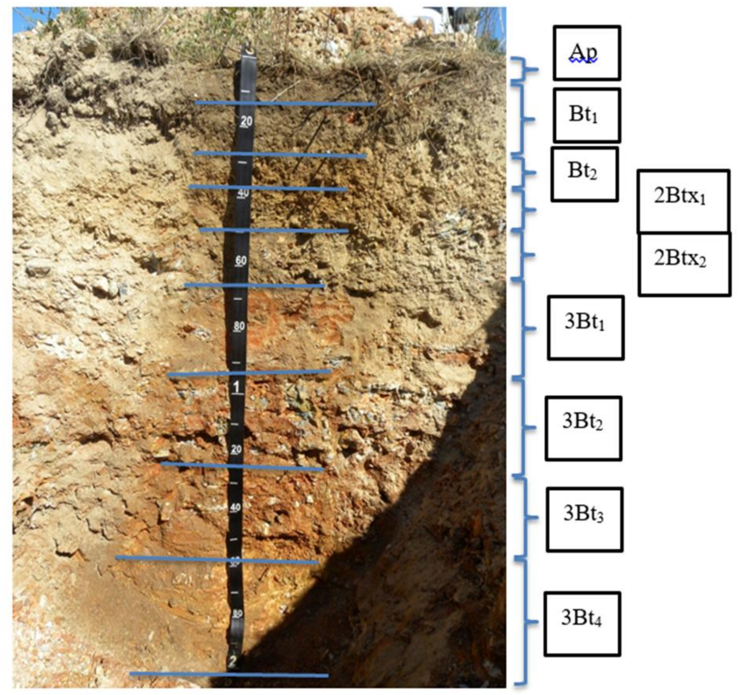

Figure 4. Horizon depths and designations of the Scholten pedon.

Poynor Soils

The Poynor series does not contain a fragipan or fragic features (Figure 5). This soil consists of very deep, well drained, moderately permeable soils on hillslopes. They formed in gravelly colluvium weathered from dolomite or limestone and the underlying clayey residuum weathered from shale.

Table 2. Soil profile description summary for the Poynor pedon.

Poynor series soil profile							
Horizon	Depth (cm)	Matrix colors (moist)	Texture	Coarse fragments > 2 mm (%)	Clay content (%)	Structure	pH (H_2O, 1:1)
Ap	0 to 20	10YR 4/3	silt loam	38	10.3	weak fine subangular blocky	6.1
BA	20 to 35	10YR 5/4	silty clay	56	54.3	moderate fine subangular blocky	6.4
Bt_1	35 to 66	7.5YR 5/4	silty clay loam	43	30.3	moderate fine subangular blocky	5.6
$2Bt_2$	66 to 98	2.5YR 4/6	clay	9	58.3	moderate medium angular blocky	5.0
$2Bt_3$	98 to 124	2.5YR 4/6	clay	37	56.0	moderate medium subangular blocky	4.7
$2Bt_4$	124 to 203	2.5YR 4/6	clay	65	67.0	moderate medium subangular blocky	4.7

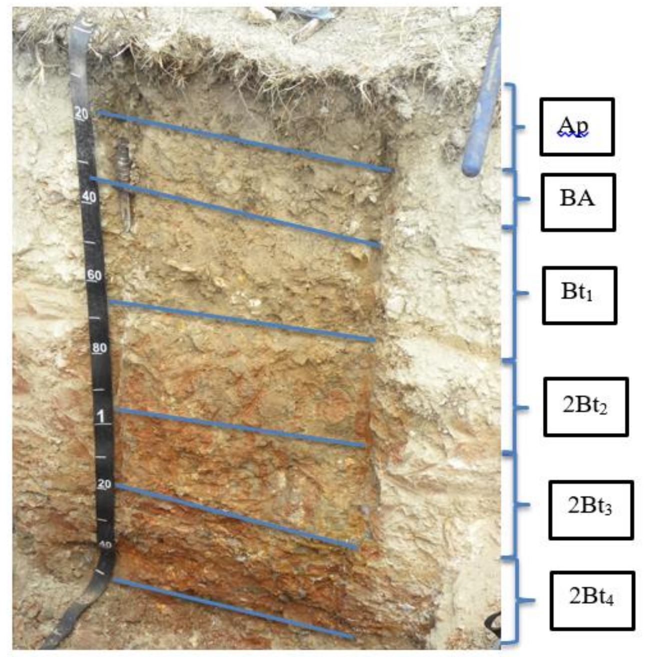

Figure 5. Horizon depths and designations of the Poynor pedon.

Results

Table 3. Air Temperature versus Soil Temperature

Month	Mean Monthly Air Temp Journagan Ranch (˚C)	Mean Monthly Soil Temp at 50 cm (˚C)	Temperature Difference [Soil Temp. 50 cm – Air Temp.] (˚C)	Mean Monthly Soil Water Content (m^3/m^3)	Mean Monthly Soil Temp at 50 cm (˚C)	Temperature Difference [Soil Temp. 50 cm – Air Temp.] (˚C)	Mean Monthly Soil Water Content (m3/m3)
		Scholten Series			Poynor Series		
January	0.0	4.5	4.5	0.37	4.4	4.4	0.20
February	2.3	4.9	2.6	0.39	4.9	2.6	0.22
March	6.9	6.9	0.0	0.40	7.2	0.3	0.24
April	13.1	11.3	-1.8	0.40	11.9	-1.2	0.21
May	17.8	15.4	-2.4	0.40	16.5	-1.3	0.19
June	22.3	19.2	-3.1	0.37	20.6	-1.7	0.14
July	23.7	21.3	-2.4	0.32	22.5	-1.2	0.08
August	23.0	22.0	-1.0	0.30	22.8	-0.2	0.09
September	20.2	20.7	0.5	0.32	21.2	1.0	0.08
October	13.3	16.8	3.5	0.34	17.0	3.7	0.11
November	6.1	11.2	5.1	0.35	11.4	5.3	0.14
December	2.6	7.6	5.0	0.37	7.5	4.9	0.18
Mean	**12.6**	**13.5**	**0.9**	**0.36**	**14.0**	**1.4**	**0.16**

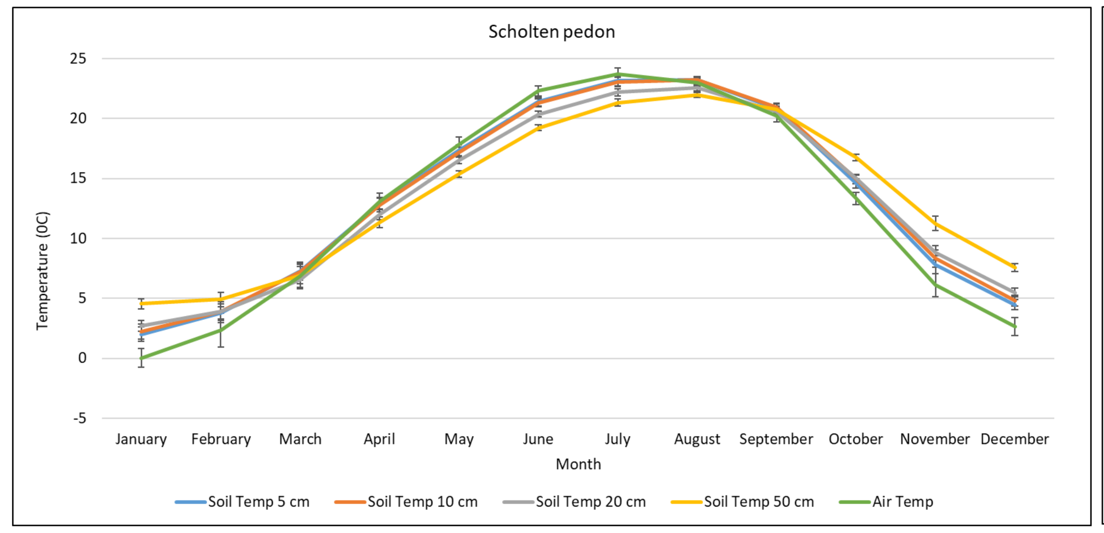

Figure 6. Scholten: Air Temp vs Soil Temp.

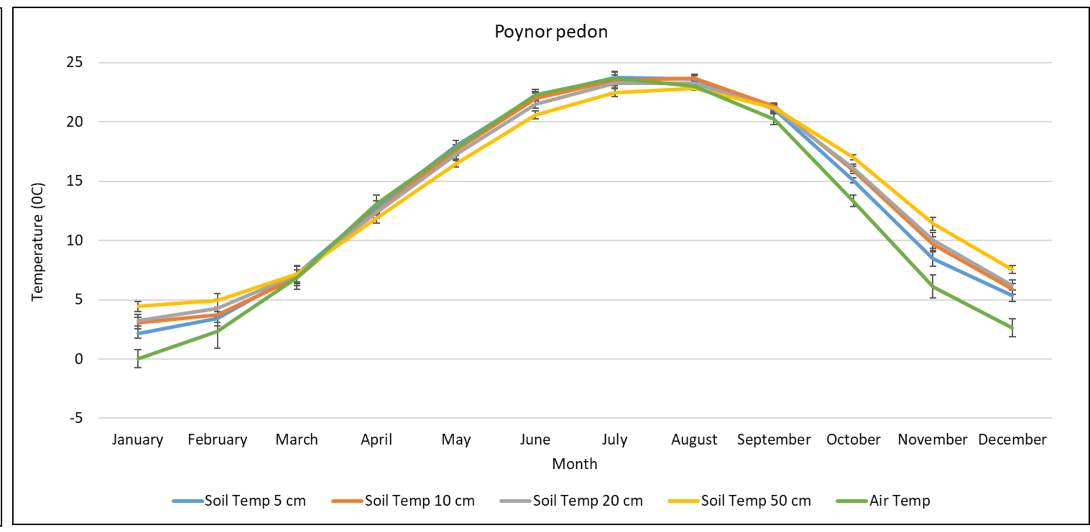

Figure 7. Poynor: Air Temp. vs Soil Temp.

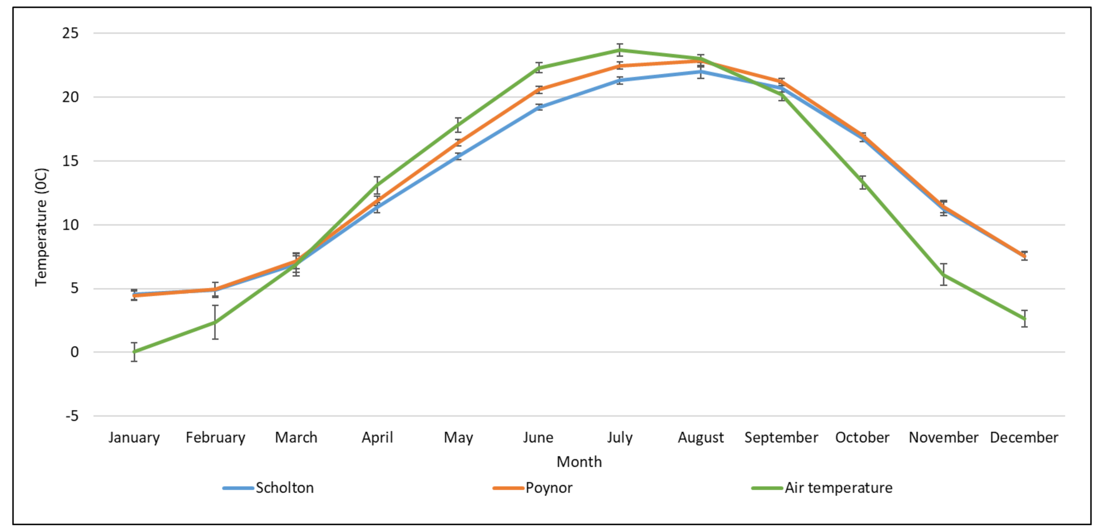

Figure 8. Scholten-Poynor: Air Temp. vs Soil Temp. (50 cm)

The mean annual soil temperature observed at the Scholten soil (13.5° C) was 0.5° C cooler than the mean annual soil temperature at the Poynor (14.0° C). This study showed little difference in mean soil temperatures between soil types from January to April and from August to December. During the months of May, June and July the Poynor mean soil temperature was higher (1.1° C, 1.4° C and 1.2° C respectively) than the Scholten mean soil temperature. Error bars are ±1 Standard Error.

Conclusions

- Results suggest that the mean annual soil temperature of fragipan soils are cooler than adjacent soils with no fragipan properties.
- The greatest temperature differences between mean soil temperature and mean air temperature were observed in November (5.1° C for Scholten soil and 5.3° C for Poynor soil); December (5.0° C for Scholten soil and 4.9° C for Poynor soil); and January (4.5° C for Scholten soil and 4.4° C for Poynor soil).
- The smallest difference was during the month of March (0° C for Scholten soil and 0.3° C for Poynor soil).
- The study also indicated that the mean annual soil temperature in the Ozark Highlands can vary by soil series depending on soil properties affecting heat transfer within pedons.
- The results of this study emphasizes the importance of understanding soil forming factors and soil forming processes over short distances (e.g. soil landscapes or catenas) or longer distances (e.g. Major Land Resource Areas or Soil Temperature Regimes) when studying soil temperature variation both in space and time.